

**APPENDIX T**

Running the internal I/O lines in the conventional way at high bus cycle rates is not possible. In the preferred method, several (preferably 4) bytes are read or written during each cycle and the column access path is modified to run at lower rate (the inverse of the number of bytes accessed per cycle, preferably  $\frac{1}{4}$  of the bus cycle rate). Three different techniques are used to provide the additional internal I/O lines required and to supply data to memory cells at this rate. First, the number of I/O bit lines in each subarray running through the column decoder 147A and 147B is increased, for example, to 16, eight for each of the two columns of column sense amps and the column decoder selects one set of columns from the "top" half 148 of subarray 150 and one set of columns from the "bottom" half 149 during each cycle, where the column decoder selects one column sense amp per I/O bit line. Second, each column I/O line is divided into two halves, carrying data independently over separate internal I/O lines from the left half 147A and right half 147B of each subarray (dividing each subarray into quadrants) and the column decoder selects sense amps from each right and left half of the subarray, doubling the number of bits available at each cycle. Thus each column decode selection turns on  $n$  column sense amps, where  $n$  equals four (top left and

right, bottom left and right quadrants) times the number of I/O lines in the bus to each subarray quadrant (8 lines each x 4 = 32 lines in the preferred implementation). Finally, during each RAS cycle, two different subarrays, e.g. 157 and 153, are accessed. This doubles again the available number of I/O lines containing data. Taken together, these changes increase the internal I/O bandwidth by at least a factor of 8. Four internal buses are used to route these internal I/O lines. Increasing the number of I/O lines and then splitting them in the middle greatly reduces the capacitance of each internal I/O line which in turn reduces the column access time, increasing the column access bandwidth even further.